Climatic Fluctuations

Weather Cycles. Real or Imaginary? WILLIAM JAMES BURROUGHS. Cambridge University Press, New York, 1992. xiv, 201 pp., illus. $39.95 or £24.95.

Weather is highly variable from day to day, month to month, year to year, decade to decade, and century to century. The search for cycles in its fluctuations, fueled by both natural curiosity and practical concern, has long occupied human beings. Interest in the field has been stimulated in recent years by the discovery of the El Niño–Southern Oscillation (ENSO), a quasi-periodic phenomenon in which, every few years, large-scale anomalies in surface pressure and sea-level temperature develop across the tropical Pacific and affect weather over much of the globe; and the Quasi-Biennial Oscillation (QBO), an alternation of easterly and westerly winds in the equatorial stratosphere with an interval between successive phases of 20 to 36 months. In his excellent book *Weather Cycles—Real or Imaginary?* W. J. Burroughs objectively examines fluctuations in the weather as observed both instrumentally and indirectly, through analysis of tree rings, varves (stratified clay of glacial origin), ice cores, glaciers, and ocean sediments. With the natural variability of the atmosphere—a complex nonlinear system—as background, Burroughs presents the evidence for and against cycles and describes the physical basis for some of the best-understood examples of apparently cyclical behavior.

By the late 1970s over a thousand papers had been published on sunspot cycles and their possible association with weather changes. A graph in the first chapter of *Weather Cycles* showing the high positive correlation over two 11-year sunspot cycles between the variation in the mean number of sunspots and the level of Lake Victoria in East Africa illustrates the difficulty experienced by researchers of weather cycles: apparently strong and significant correlations over limited periods of record fail to hold up in the face of independent or subsequent data. Despite a very high correlation from 1902 to 1921, the prediction of a high lake level at the time of the next maximum in sunspot number proved inaccurate.

Burroughs explores a number of extraterrestrial influences on weather variability, including the relationship between sunspots and other solar phenomena such as faculae (bright areas near the solar limb) and the changes in total solar output. The discussion goes beyond the level of the many statistical studies relating climate variability to the sunspot cycle and the Hale magnetic cycle (a 22-year cycle in solar activity that is a combination of the 11-year sunspot cycle and the reversal of the magnetic polarity of adjacent sunspots between alternate cycles). Data from the Solar Maximum Mission satellite showed that, from 1980 to 1987, aside from short-term variations, the total output from the sun varied in direct proportion to the number of sunspots by ±0.04 percent. The observed variability in total solar output (less than 0.1 percent) is too small to account for the major observed changes in climate, but the percentage variation in the ultraviolet wavelengths is much larger. Thus a plausible first step in developing a physical explanation of a solar-climate connection is an examination of the effect of solar variability in the ultraviolet wavelengths on the ozone and chemistry of the upper atmosphere. Tidal effects of the sun and moon on Earth's crust could also bring about changes in climate by giving rise to volcanic activity, which can produce direct cooling of the atmosphere.

Another theory of climate change, the Milankovitch theory, is based on the variations in Earth's orbit. Solar radiation reaching Earth as a function of latitude and season varies significantly with changes in orbital precession, tilt, and shape, which have periodicities of 19 to 23, 41, 100, and 413 thousand years. These changes in the orbital parameters result in significant variation in the intensity of radiation reaching Earth at high northern latitudes in summer; this intensity is critical to the growth and decay of ice sheets. Over the past 600,000 years the amount of solar radiation reaching 65° north latitude during the summer has varied by more than 9 percent. Global climate models have indicated that the orbital variations are sufficient to explain major fluctuations in the Northern Hemisphere ice sheets that have occurred in the past.

The strongest evidence for weather cycles exists for the ENSO, the QBO, the 11-year sunspot cycle, the 20-year cycle in power spectra, and the variations in climate associated with the changes in Earth's orbit. In fact almost every possible atmospheric periodicity has been found in some record, somewhere, at some time or other, but relatively few have appeared with high frequency. In his final chapter Burroughs puts the search for these elusive weather cycles into perspective with a discussion of the predictability of complex nonlinear systems (chaos theory). He concludes that, with two major exceptions—the 20-year cycle found repeatedly in many records around the world, which could be related to solar or lunar influences, and the variations described by the Milankovitch theory—all of the cycles found in the record could be explained by natural variations caused by nonlinear processes and feedback in the climate system (climatic autovariance). Although this conclusion may be disappointing to some in view of the enormous research effort that has been put into the search for weather cycles and their physical explanations, we can be consoled by the fact that this search itself has contributed significantly to our understanding of Earth's climate and its daily fluctuations.

This book will serve the general reader interested in the weather and its changes as well as the working atmospheric scientist. Burroughs uses a minimum of mathematics, rendering the book accessible to the layperson. He devotes an entire chapter to a readable explanation of the statistical techniques used to study meteorological variables and their proxies, carefully describing the fundamentals of time series, sampling theory, aliasing, running means and filters, harmonic analyses and power spectra, and red, white, and pink noise. For the more advanced reader, a more detailed mathematical background is given in the appendix.

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Fluorination Methods

Synthetic Fluorine Chemistry. GEORGE A. OLAH, RICHARD D. CHAMBERS, and G. K. SURYA PRAKASH, Eds. Wiley, New York, 1992. xiv, 402 pp., illus. $95 or £80. From a symposium, Feb. 1990.

In recent years there has been a virtual explosion of interest in the chemistry of fluorine-containing compounds, especially with regard to the development of new fluoropharmaceuticals, agrichemicals, and fluoropolymers. There is now hardly an area of chemistry or biochemistry where fluorine chemistry does not have a significant impact, and synthetic fluorine chemistry is becoming of interest to increasing numbers of organic and inorganic chemists of all persuasions.

This book consists of reviews of areas of current interest in fluorine chemistry largely deriving from recent results from the laboratories of the authors, all of them leaders in the field. A number of the chapters provide unique perspectives on specific areas of synthetic methodology. One technique that has recently become mature and capable of commercialization is direct fluorination, a technique that allows the use of elemental fluorine to totally fluorinate cer-